

DØ Results from Run 2



Yuri Gershtein
Brown University
for the DØ collaboration

A Truly International Collaboration

Totals:

- 18 countries

Europe, Asia, and
North, Central and
South Americas

- 73 institutions &
labs

- 33 US
- 40 non-US

- 646 physicists

- 334 US
- 312 non-US

The DØ Collaboration

Ann Heinson, UC Riverside

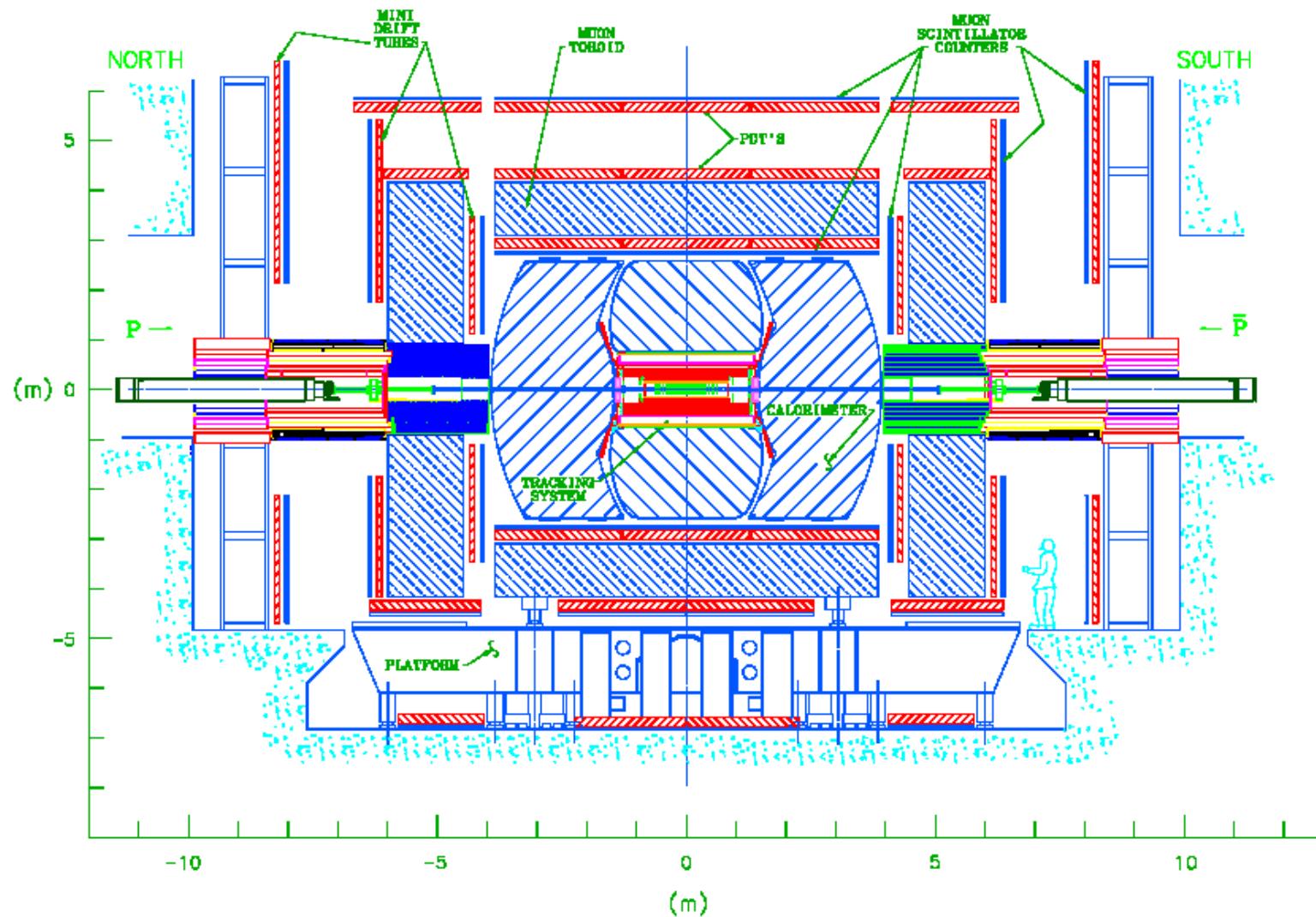
Country / Institution	Country / Institution	Country / Institution	Country / Institution
U. of Arizona	U. de Buenos Aires	LAFEX, CBPF, Rio de Janeiro	IHEP, Beijing
U. of California, Berkeley	U. of California, Riverside	State U. do Rio de Janeiro	U. de los Andes, Bogotá
U. of California, Riverside	Cat State U., Fresno	State U. Paulista, São Paulo	
Lawrence Berkeley Nat. Lab			
Florida State U.			
Fermilab			
U. of Illinois, Chicago			
Northern Illinois U.			
Northwestern U.			
Indiana U.			
U. of Notre Dame			
Iowa State U.			
U. of Kansas			
Kansas State U.			
Louisiana Tech U			
U. of Maryland			
Boston U.			
Northeastern U.			
U. of Michigan			
Michigan State			
U. of Nebraska U.			
Princeton U.			
Columbia U.			
U. of Rochester			
SUNY, Stony Brook			
Brookhaven Nat. Lab			
Langston U.			
U. of Oklahoma			
Brown U.			
U. of Texas, Arlington			
Texas A&M U.			
Rice U.			
U. of Virginia			
U. of Washington			
FOM-NIKHEF, Amsterdam	JINR, Dubna	Lund U.	HCIP, Hochiminh City
U. of Amsterdam/NIKHEF	ITEP, Moscow	RIT, Stockholm	
U. of Nijmegen/NIKHEF	Moscow State U.	Stockholm U.	
	IHEP, Protvino	Uppsala U.	
	PNPI, St Petersburg		

Run 2 and our Physics Program

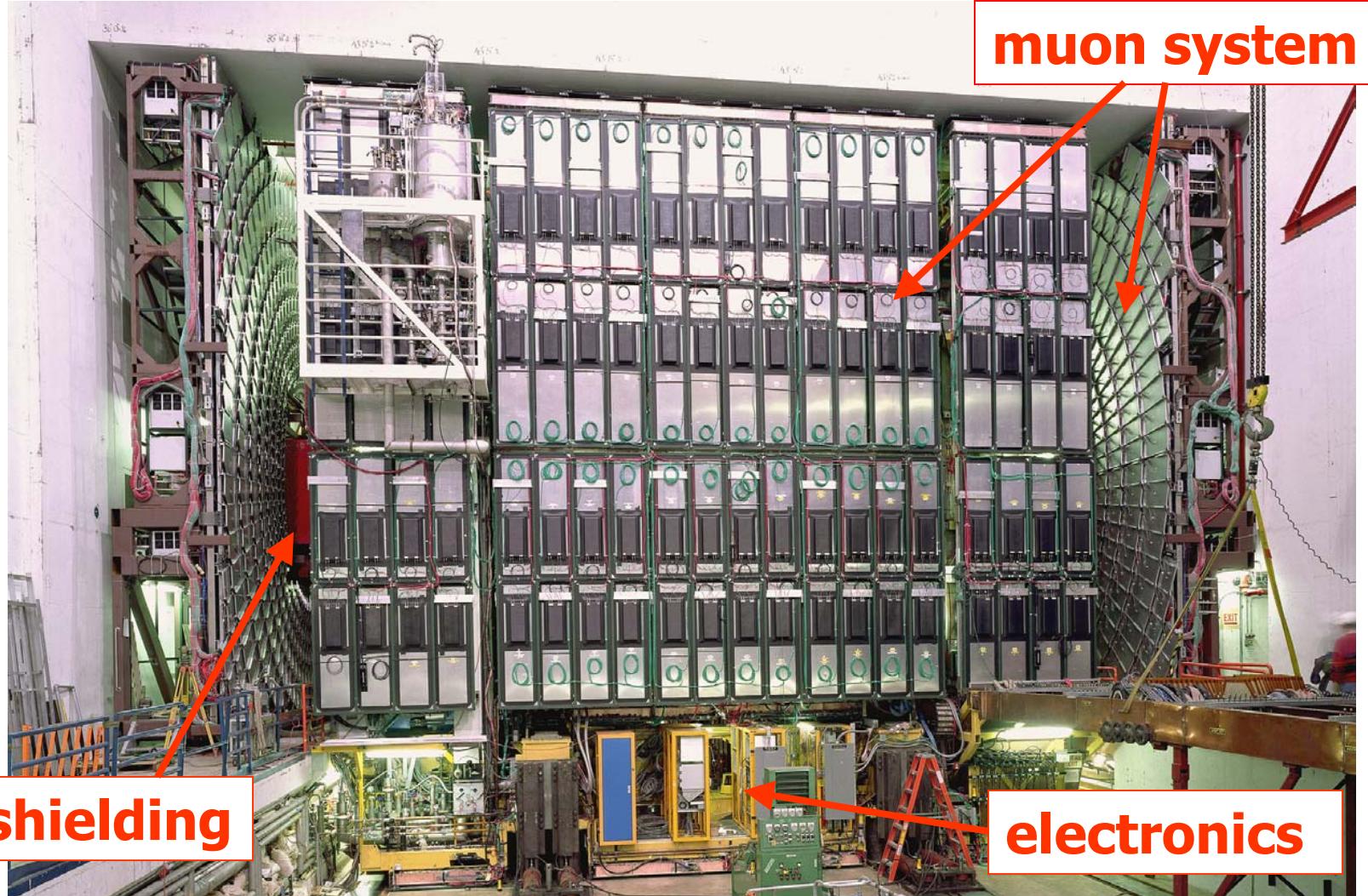
- Started March 2001
 - $E_{cm} = 1.96 \text{ TeV}$
 - Peak $L = 2.1 \cdot 10^{31}$
 - Delivered $\sim 50 \text{ pb}^{-1}$
- Detector commissioning almost complete
- First physics results from $\sim 10 \text{ pb}^{-1}$ at new E_{cm}
- Physics Program
 - Top, W, Higgs
 - New Phenomena
 - B-physics
 - QCD



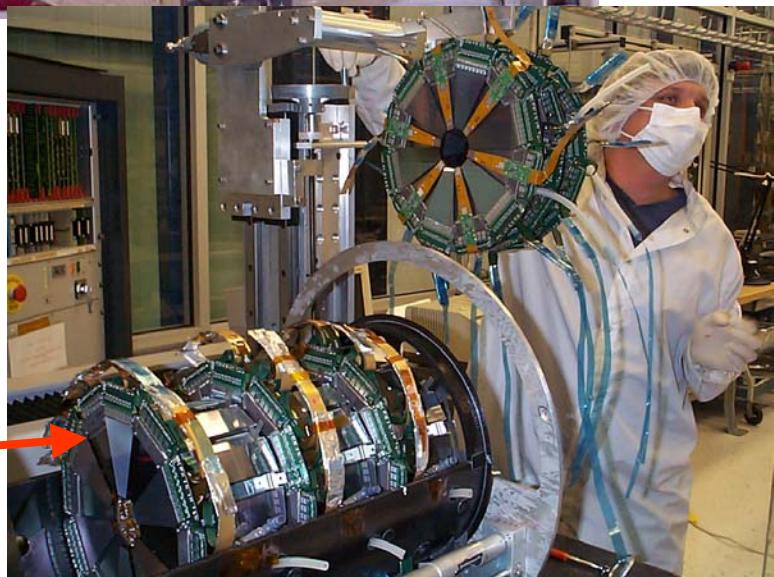
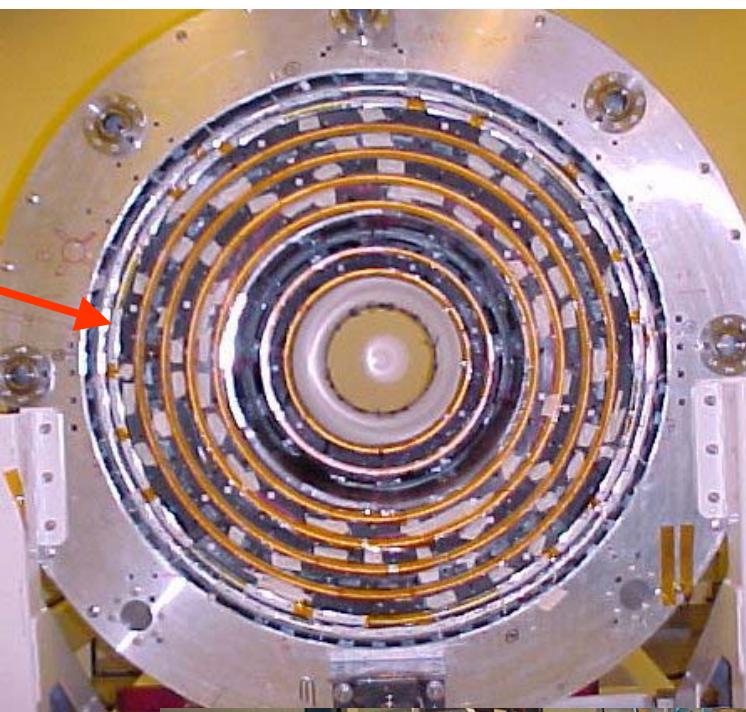
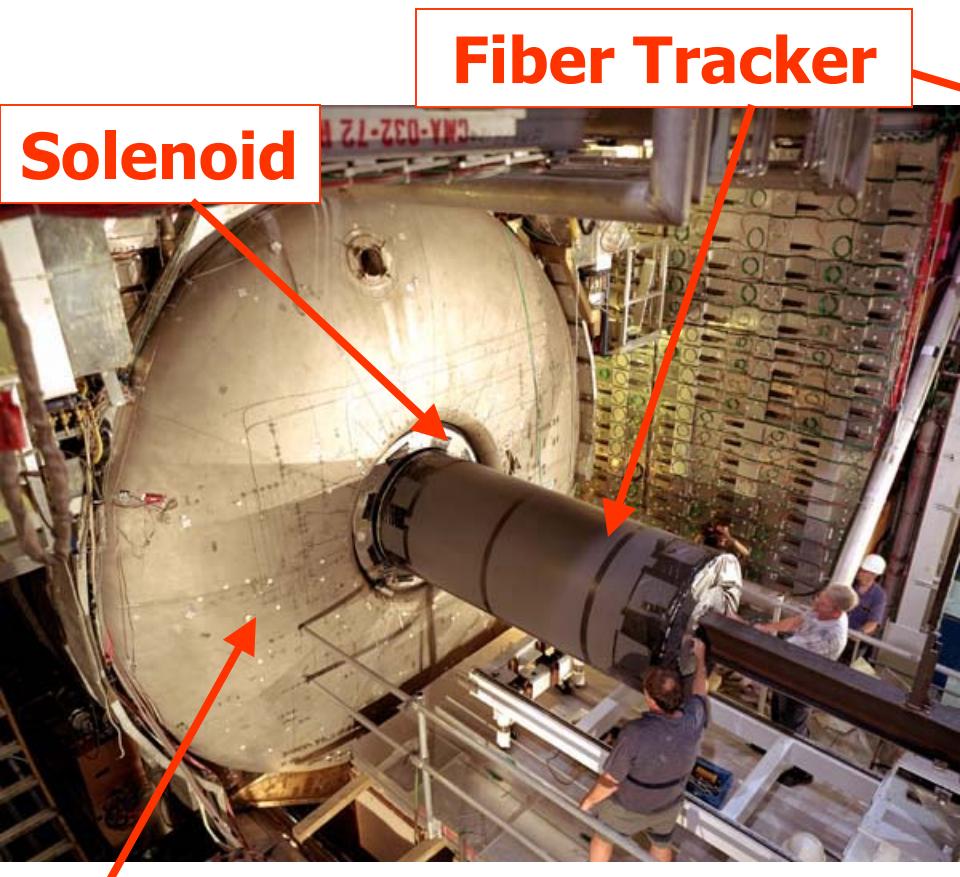
DØ Detector



DØ Detector



DØ Detector



**Central
Calorimeter**

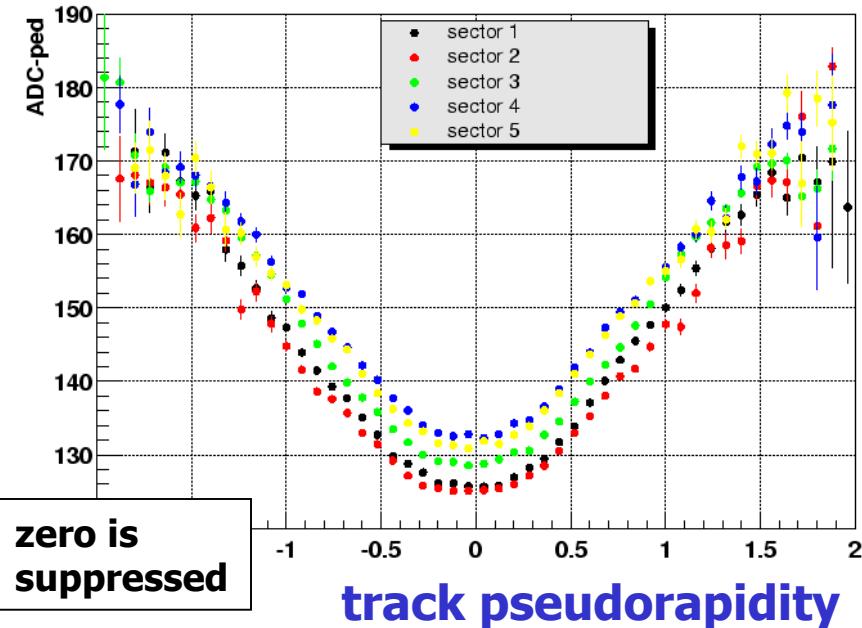
Silicon

Detector Performance: Tracking

Scintillating Fiber Tracker (CFT) first time in a collider detector

- performs as expected
- $\varepsilon > 98\%$ (*including dead channels*)
- good light yield
- reconstruct tracks

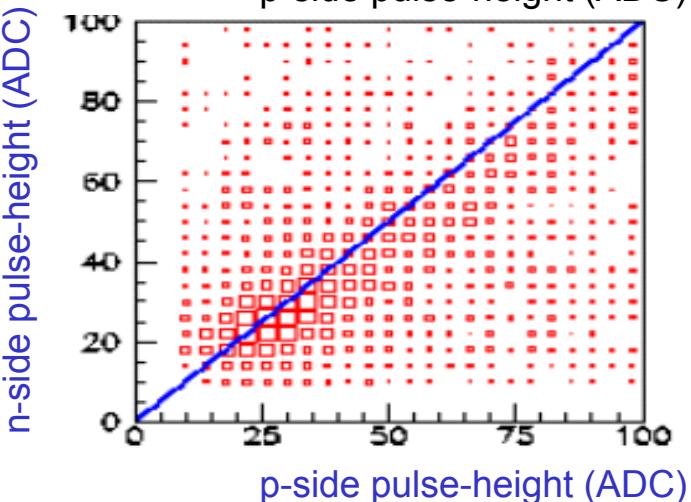
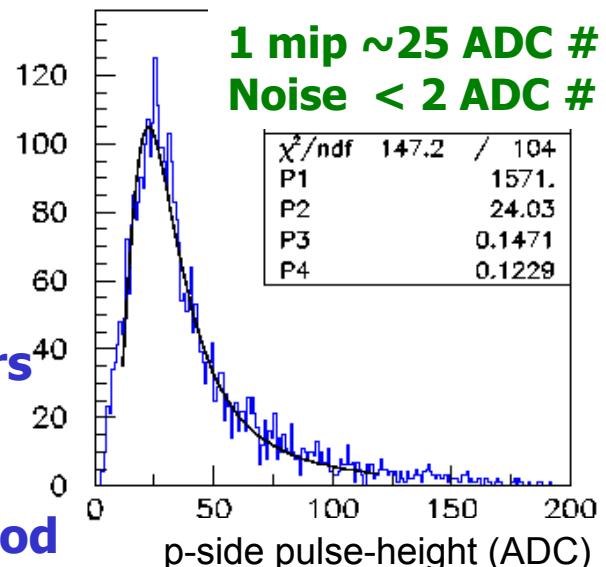
fiber light yield



Silicon (SMT)

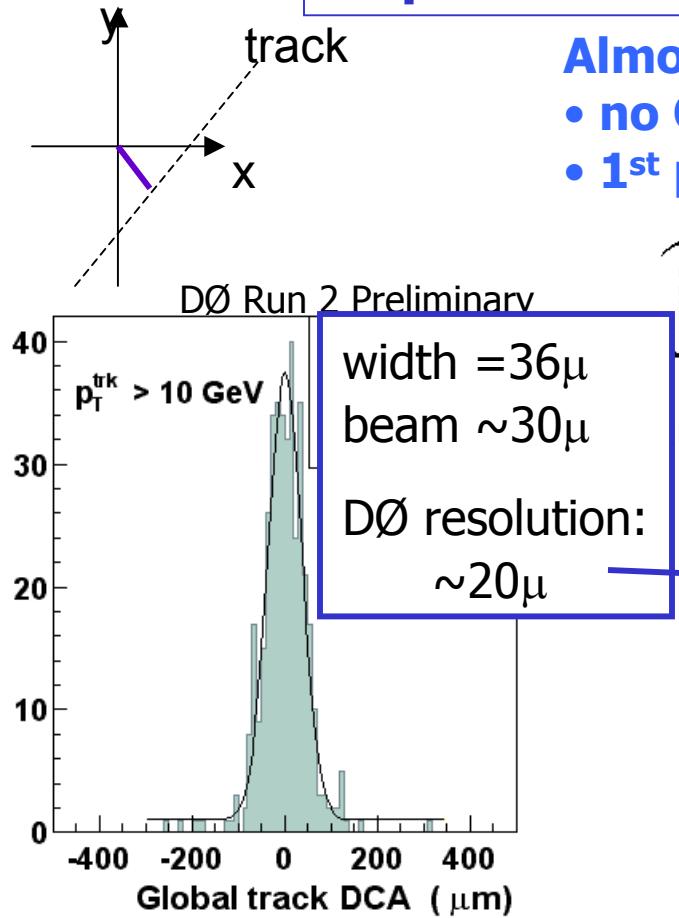
- good S/N
- 95% detectors
are working
- Clusters are
being understood
- $\varepsilon > 97\%$
(*incl. dead*)

Silicon cluster charge

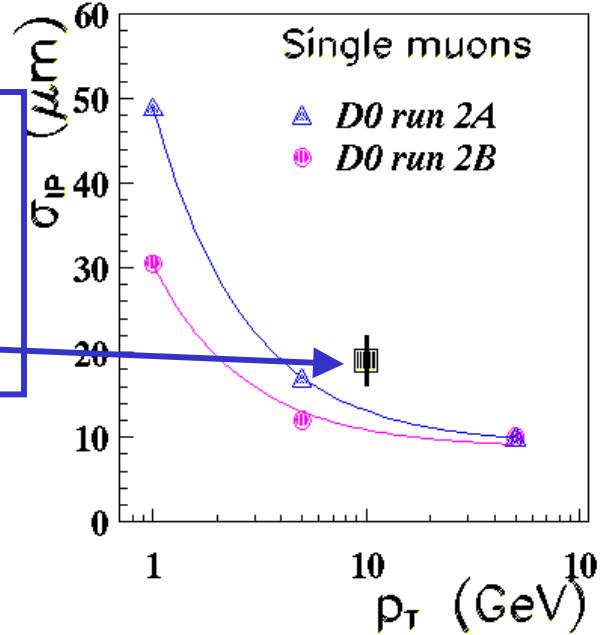


Detector Performance: Tracking

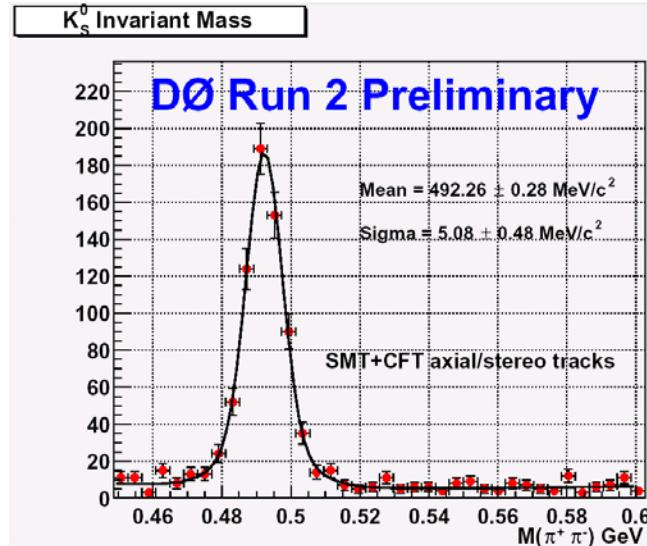
Impact Parameter



Almost on target with
• no CFT alignment
• 1st pass SMT alignment

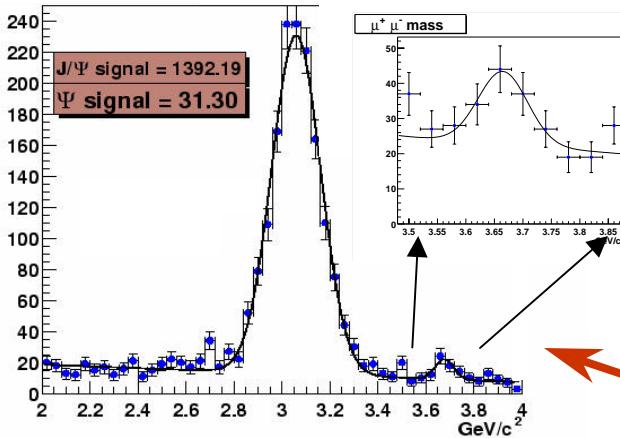


Secondary Vertices

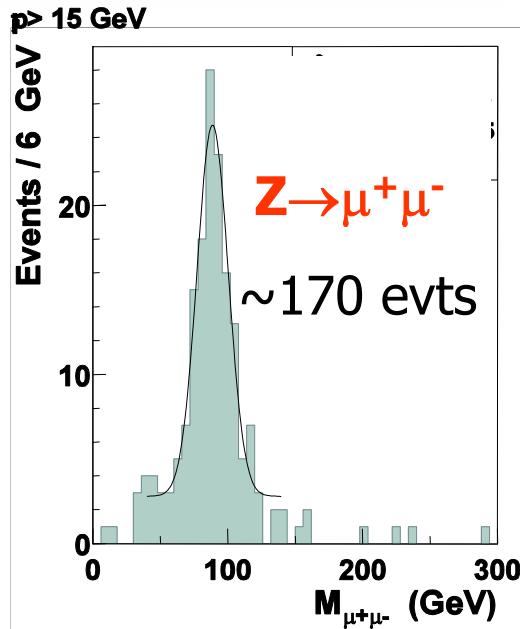


Detector Performance

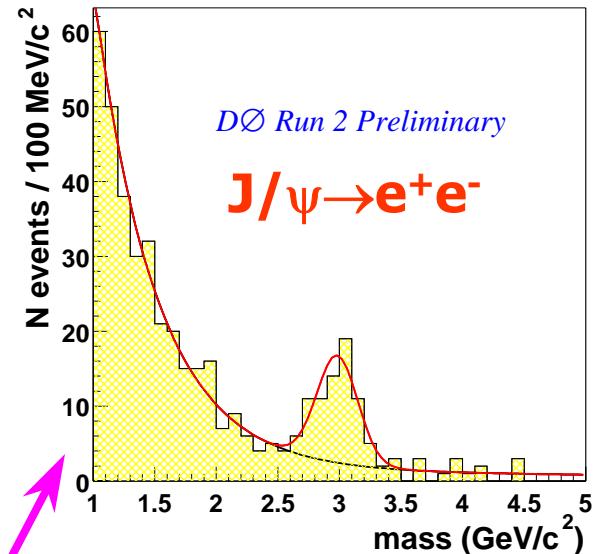
J/ ψ and ψ'



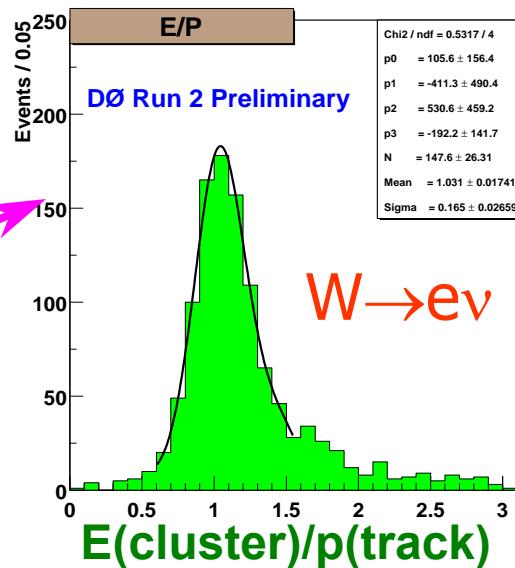
Combine tracking with other systems



Muon System

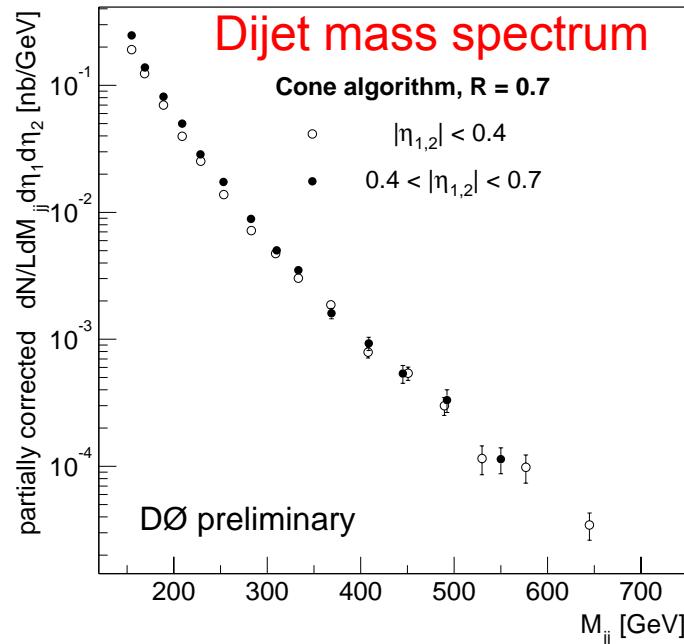
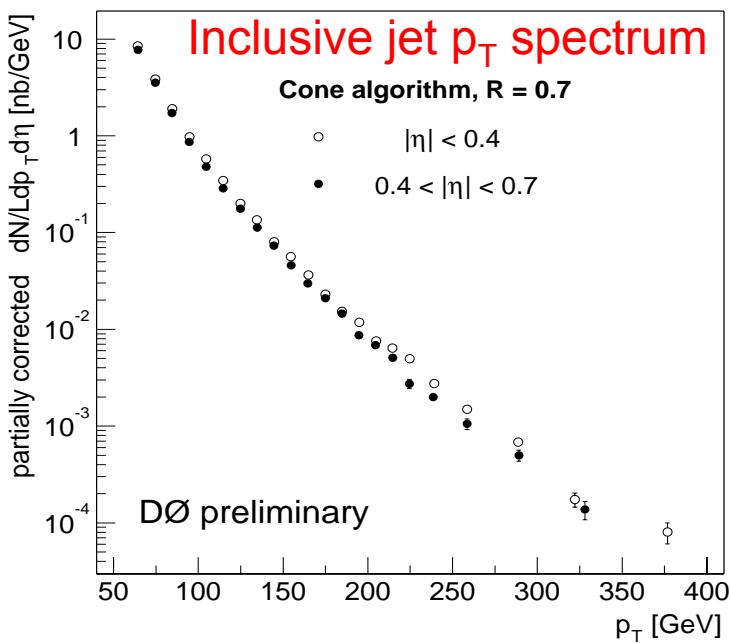


Calorimeter



Jet Physics

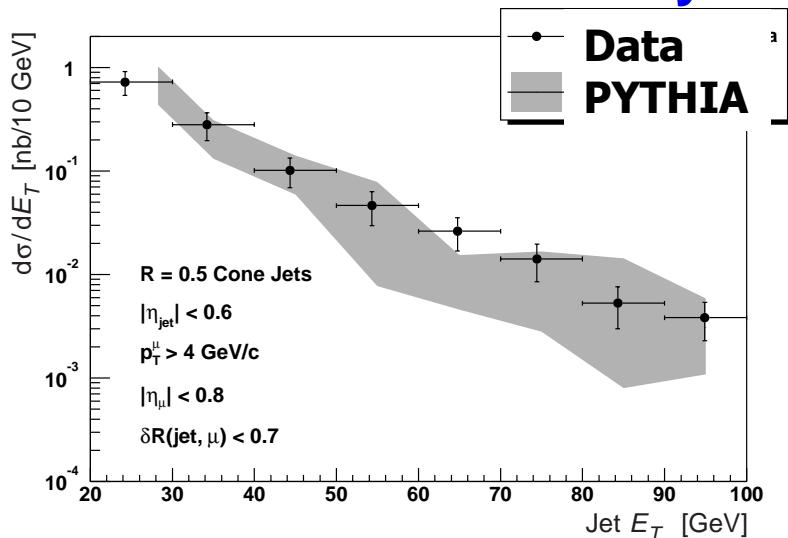
- Testing pQCD at new energy
 - 2x cross section for $E_T > 400$ GeV
- Structure functions at large x
- Compositeness, W' , Z' , etc...



- Only statistical errors
- Luminosity $L = 5.8 \text{ pb}^{-1} (\pm 10\%)$
- Preliminary jet energy scale
 - 30-50% syst. error in cross section
- Not fully corrected
 - (for unsmeering, efficiencies)

B Physics

DØ Run 2 Preliminary



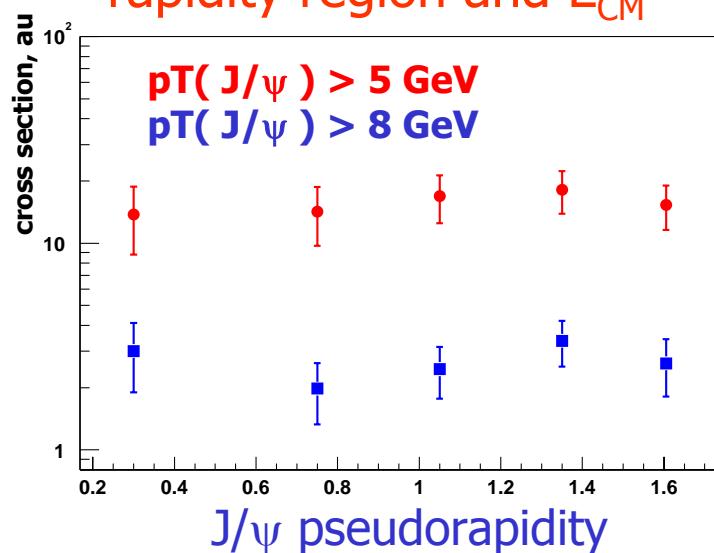
b-quark Production Cross Section

- New E_{CM}
- Luminosity $\sim 5 \text{ pb}^{-1}$
- Jet $|\eta| < 0.6$
- muon tag only, b-content from p_T^{rel} fits

- New tracking in 2 Tesla field
- Muon triggers up to $|\eta| < 2$

J/ψ Cross Section Measurement

- Luminosity $\sim 5 \text{ pb}^{-1}$
- First measurement in this rapidity region and E_{CM}

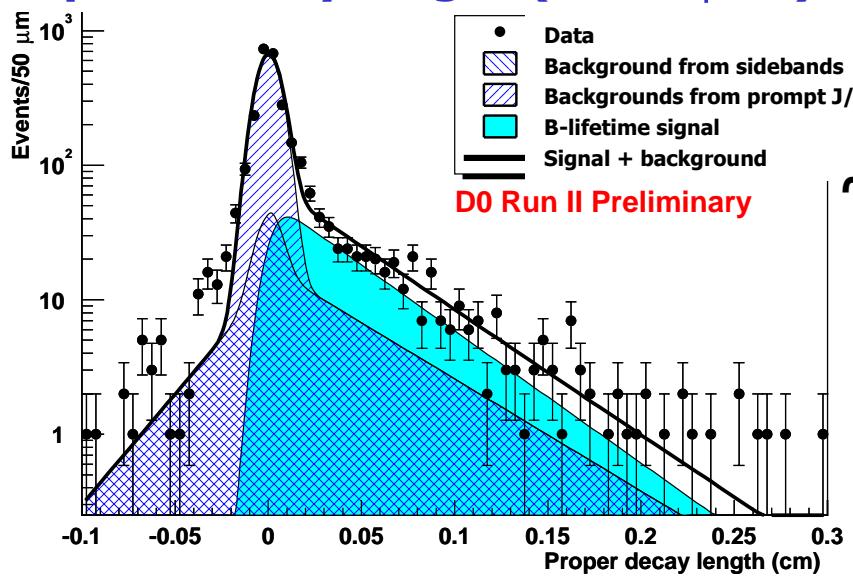


B Physics

B lifetime measurement from inclusive J/ ψ

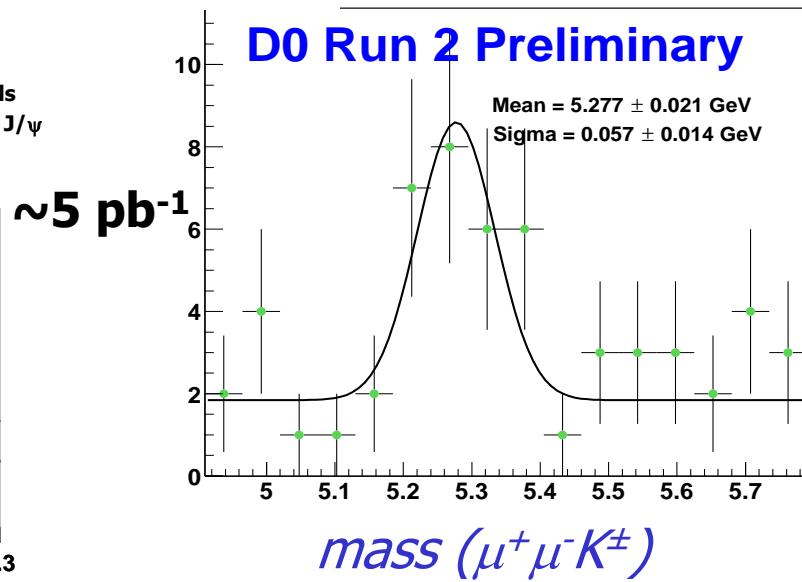
- Measured lifetime consistent with the world average
- Track errors (esp. from large SMT clusters) are being understood

Proper B decay length ($B \rightarrow J/\psi + X$)



Exclusive B reconstruction

- $B^\pm \rightarrow J/\psi K^\pm$
- First time in D \emptyset
- Expect more soon!



Electroweak Physics

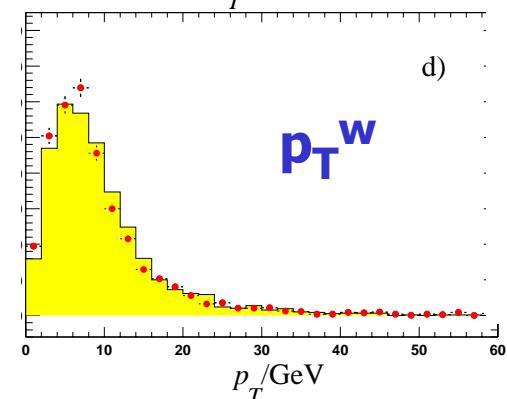
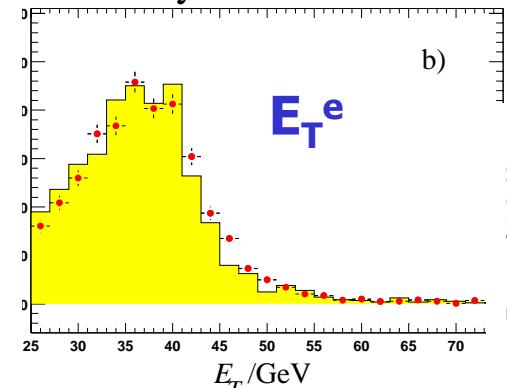
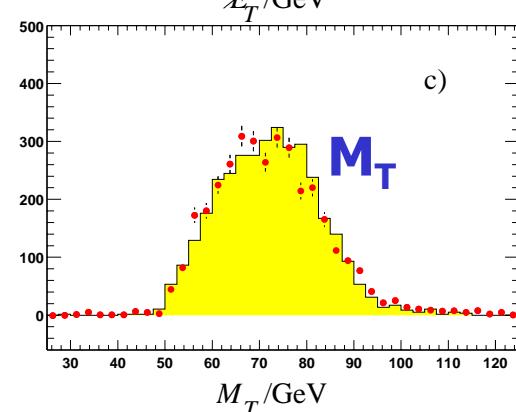
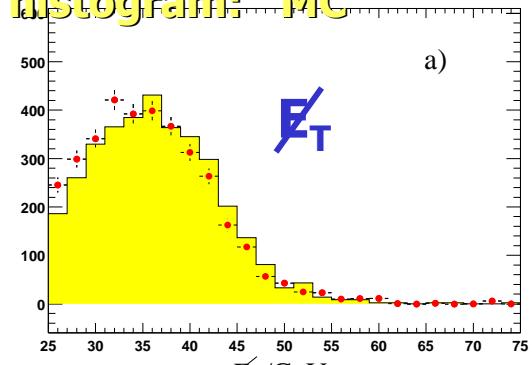
High priority measurements

- $W \rightarrow e\nu$ cross-section

dots: Data

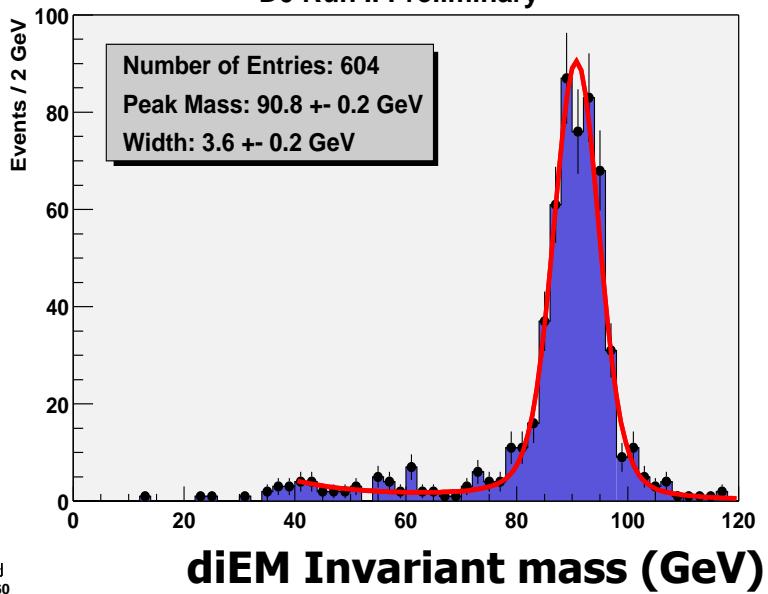
histogram: MC

D \bar{O} Run2 Preliminary



- $Z \rightarrow e^+e^-$ cross-section

D \bar{O} Run II Preliminary



W and Z Production Cross Section

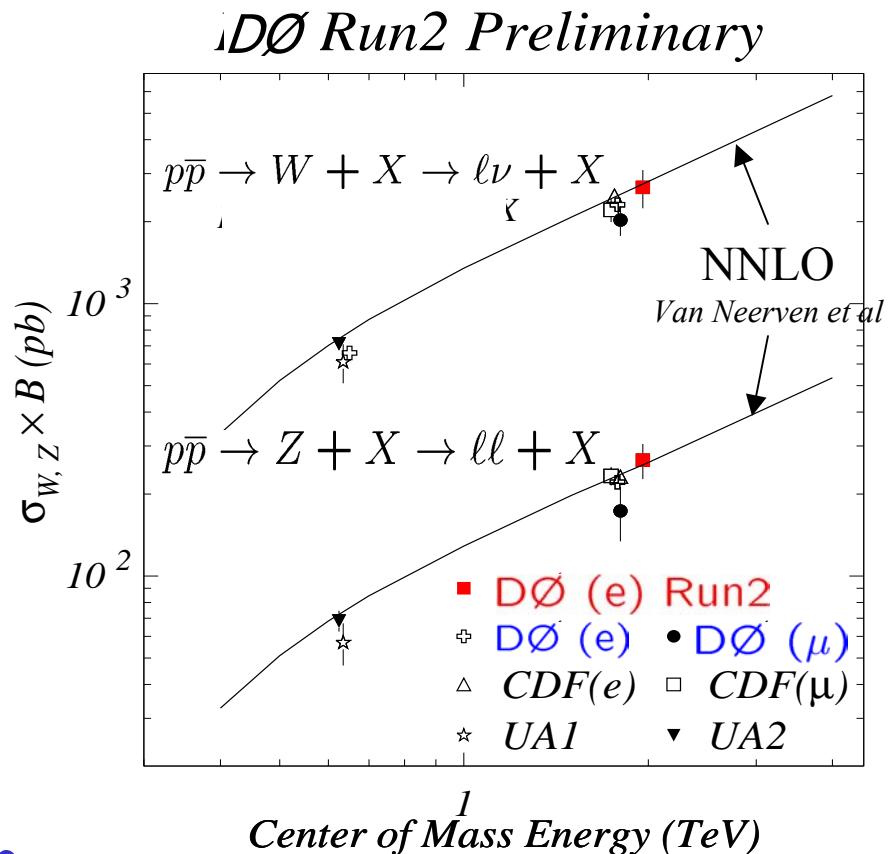
- Data Sample:

- Luminosity $\sim 7.5 \text{ pb}^{-1}$
- No. of $W \rightarrow e$: $3493 \pm 75 \pm 296$
- No. of $Z \rightarrow ee$: $186 \pm 14 \pm 10$

- First measurements of the cross sections at 1.96 TeV!

$$\sigma_Z \times B(Z \rightarrow ee) = 266 \pm 20_{\text{stat}} \pm 20_{\text{syst}} \pm 21_{\text{lumi}} \text{ pb}$$

$$\sigma_W \times B(W \rightarrow e\nu) = 2.67 \pm 0.06_{\text{stat}} \pm 0.33_{\text{syst}} \pm 0.27_{\text{lumi}} \text{ nb}$$



W and Z Production Cross section

- Since we can measure both: Ratio of cross sections
 - Most of the systematic effects cancel out

$$R = \frac{\sigma_W \cdot B(W \rightarrow e\nu)}{\sigma_Z \cdot B(Z \rightarrow ee)} = 10.0 \pm 0.8_{\text{stat}} \pm 0.6_{\text{syst}} = \frac{\sigma_W \cdot \Gamma(W \rightarrow e\nu) \Gamma_Z}{\sigma_Z \cdot \Gamma(Z \rightarrow ee) \Gamma_W}$$

- W boson width can be calculated from the above formula
 - Using $\sigma(W)/\sigma(Z)$ from theory and $\text{BR}(Z \rightarrow ee)$ from LEP

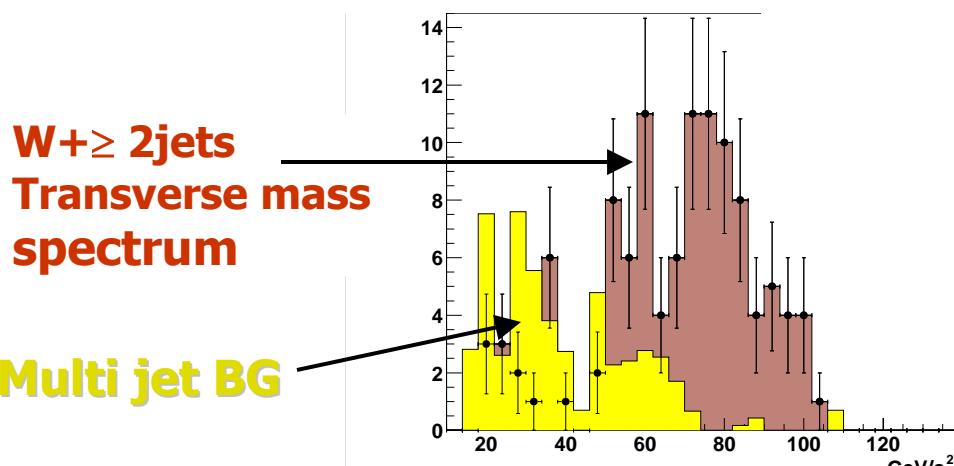
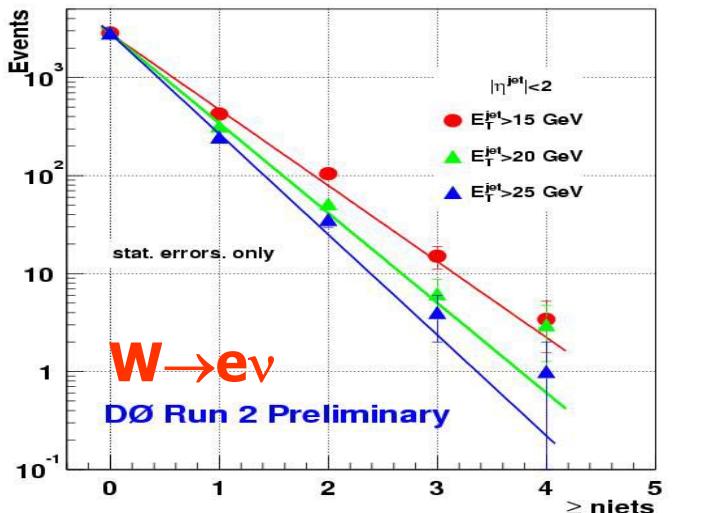
$$\Gamma_W = 2.26 \pm 0.18_{\text{stat}} \pm 0.13_{\text{syst}} \pm 0.04_{\text{theory}} \text{ GeV}$$

- In good agreement with world average

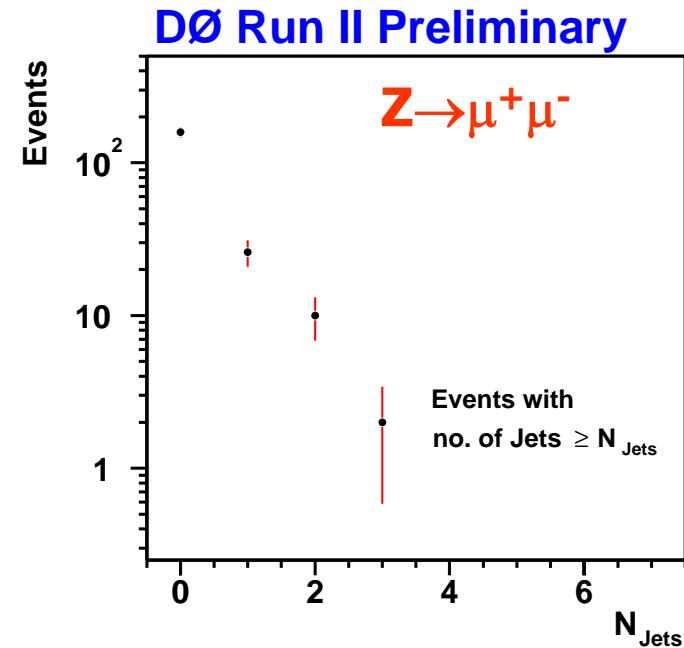
$$\Gamma_W = 2.135 \pm 0.069 \text{ GeV}$$

W/Z boson + jets events

Jet multiplicity distributions



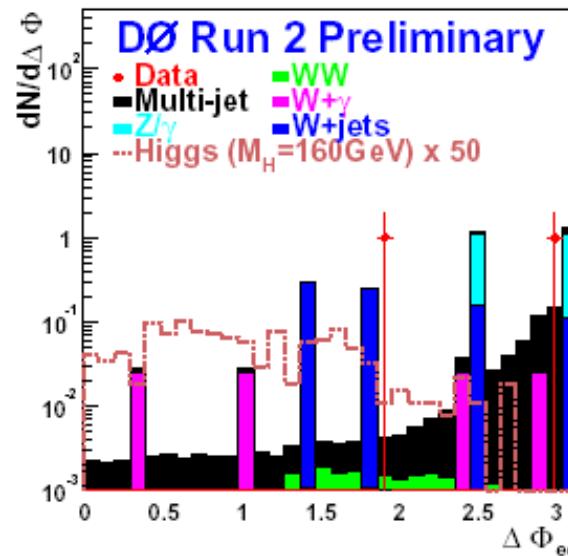
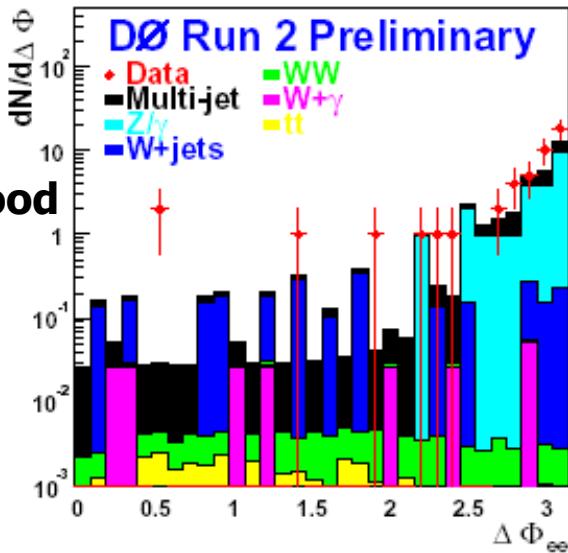
- **Top Physics: $W + \geq 3 \text{ jets}, Z + \geq 2 \text{ jets}$**
- **Higgs Physics: $W/Z + \geq 2 \text{ jets}$**
- **Need excellent b-jet identification**
 - Secondary vertex recons.
 - Soft leptons in jets



WW production

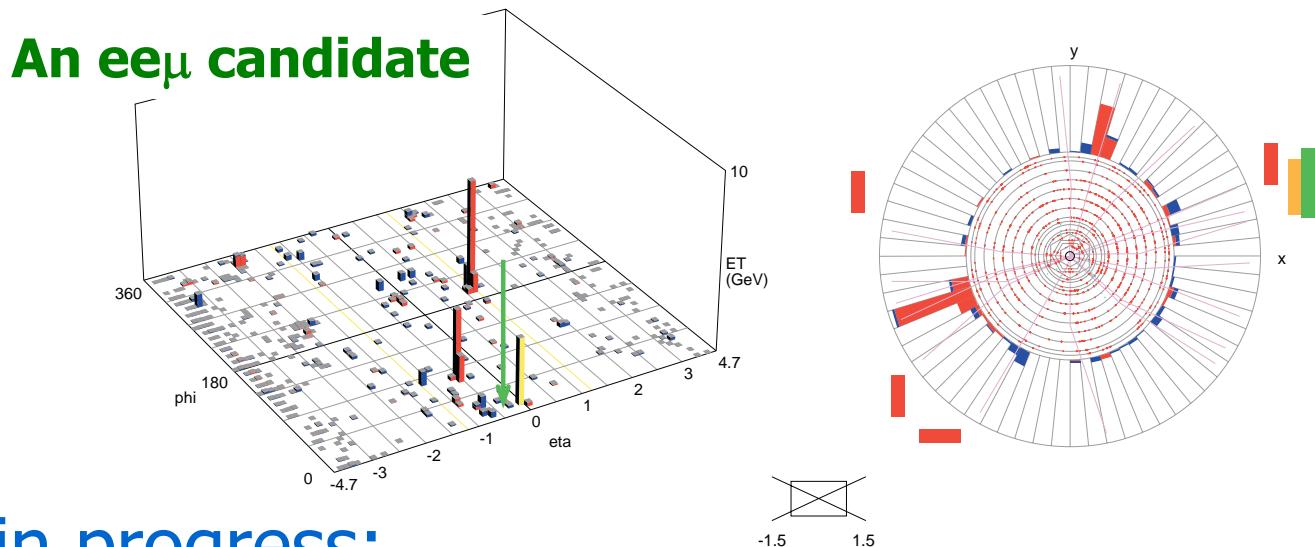
- Search for $e^+e^- \cancel{E}_T$ events
- A lot of interest in this channel (*tri-linear couplings, New Phenomena*)
- Exotic Higgs Models:
 - 4th SM family enhance Higgs cross sections by a factor of ~ 8.5 for Higgs mass between 100-200 GeV
 - Fermiophobic/Topcolor Higgs: $BR(H \rightarrow WW) > 98\%$ for $mH \geq 100$ GeV
- Backgrounds due to misidentified objects.

Azimuthal opening angle between the leptons



Search for New Phenomena

- Tri-lepton signatures
 - One of cleanest signatures of SUSY
 - for example from chargino+neutralino production



- Analyses in progress:
 - Likesign dielectrons
 - Jets+Missing Et

GMSB SUSY

- Phenomenology:

- Light Gravitino ($<<$ eV) is LSP, NLSP can be neutralino or slepton

- If neutralino NLSP:

$$\begin{aligned} p\bar{p} \rightarrow & \text{gauginos} \rightarrow W, Z, \gamma + \chi_1^0 \chi_1^0 \\ & \rightarrow \gamma\gamma + \tilde{G}\tilde{G} + X \end{aligned}$$

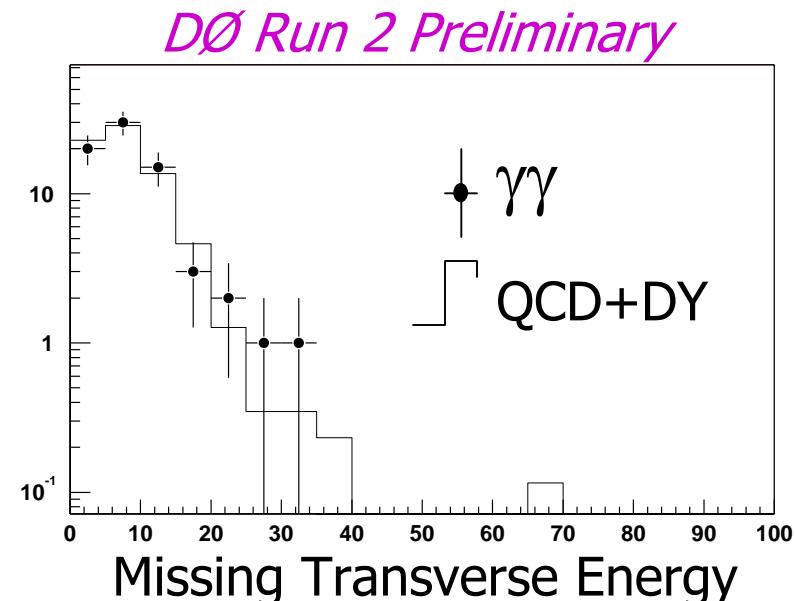
→ inclusive search for $\gamma\gamma E_T + X$

- Backgrounds:

- QCD: $\gamma\gamma, \gamma+j$
(w/ jet misidentified γ)
- $W\gamma \rightarrow e\nu\gamma$ (**track is lost**)
- $WW, WZ, DY,$

- Sensitivity is still too low to exclude SUSY points

- “Model Independent” Limit $\sigma < 0.9 pb @ 95\% CL$



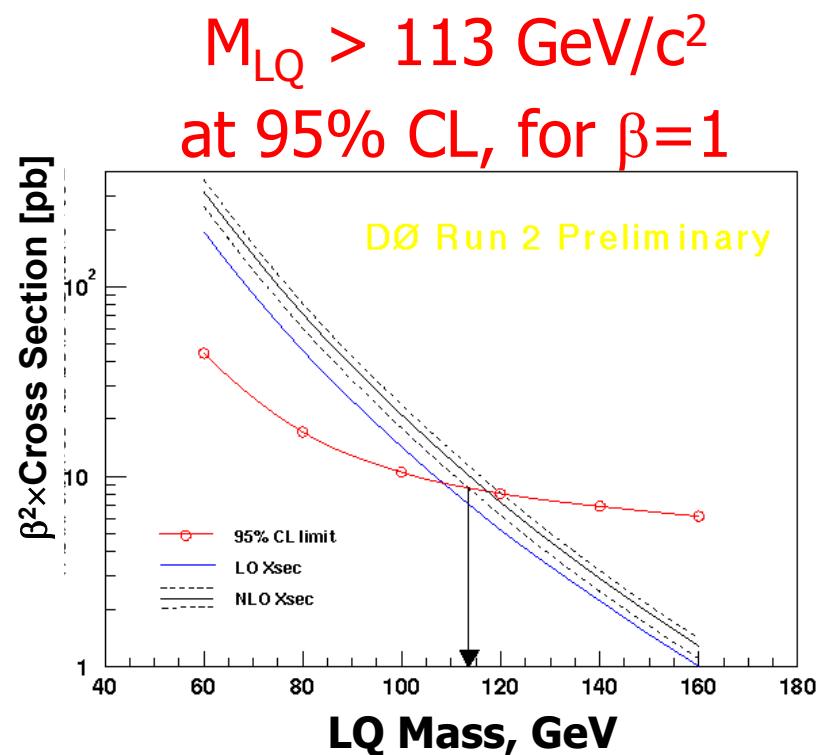
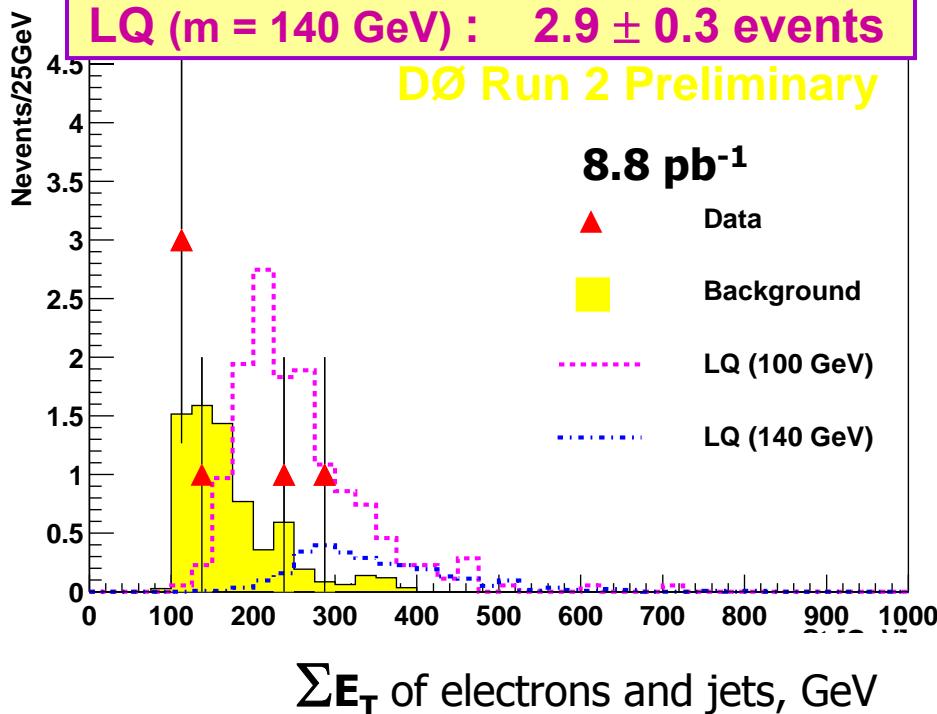
Leptoquarks

- particles with properties of both quarks and leptons
- Signature: eejj events

Data : **6 events**

BG from QCD and DY

Background : **6.9 ± 2.9 events**
LQ ($m = 100$ GeV) : **13.8 ± 1.8 events**
LQ ($m = 140$ GeV) : **2.9 ± 0.3 events**



Consistent with Run1 result

Extra Dimensions

- Search for large extra spatial dimensions via virtual graviton effects

- e^+e^- , $\gamma\gamma$ and $\mu^+\mu^-$ events

- Run2 Preliminary Limit:

- $M_S(\text{GRW}) > 0.92 \text{ TeV} (\text{ee}, \gamma\gamma)$

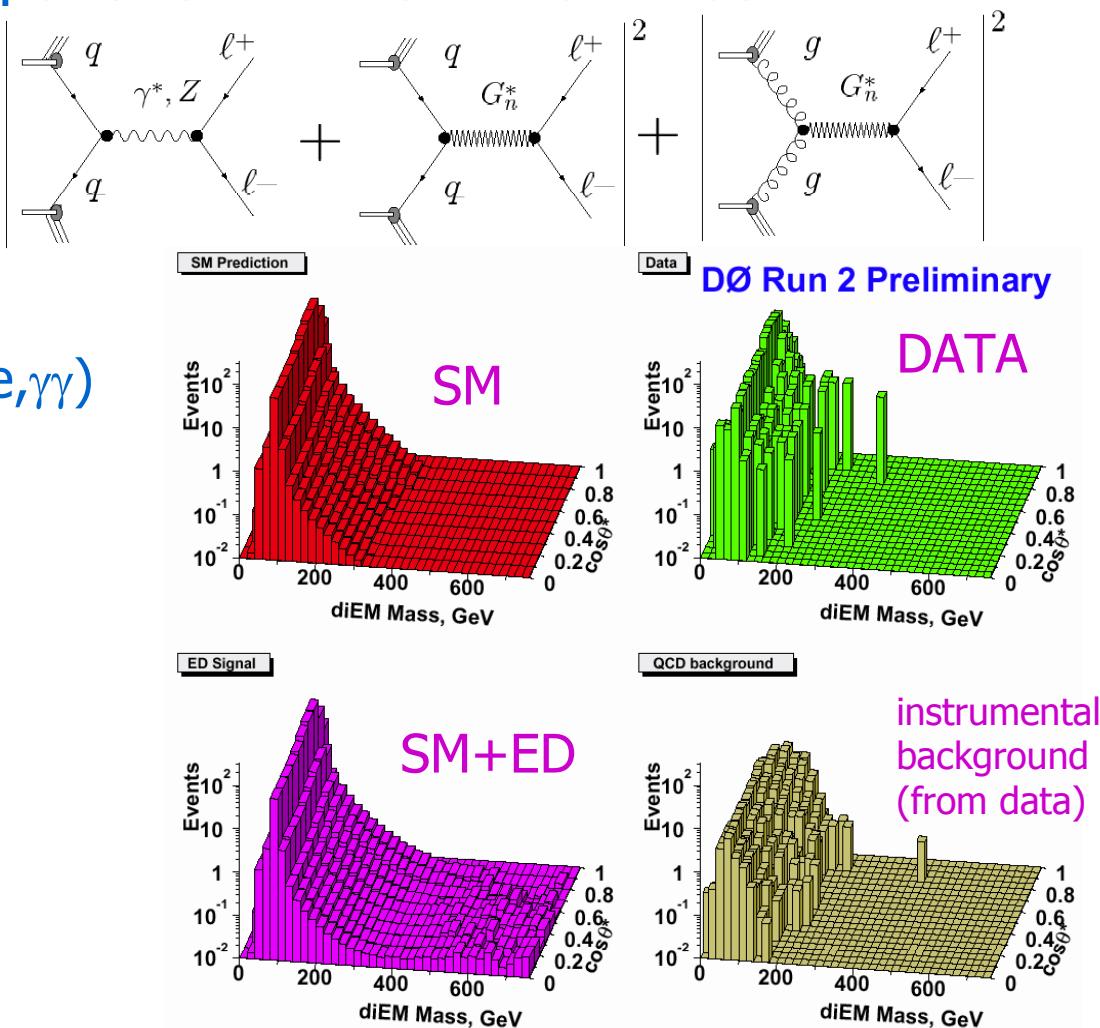
- DØ Run 1 limits:

- $M_S(\text{GRW}) > 1.2 \text{ TeV}$

- Prospects for Run 2:

- 1.5-2.5 TeV (2fb^{-1})

- 2.1 – 3.5 TeV (20 fb^{-1})



Future Prospects

- Continue to Search for New Physics
 - SUSY, strong dynamics, extra dimensions, etc...
- Measurements of cross sections at 1.96 TeV
 - W and Z boson production, jet cross sections
 - b-quark production, top quark production
- Measure W/Z Properties (A_{FB} , W mass to 30 MeV)
- Rich program of B-physics
- Comprehensive study of Top quark Properties (2 fb^{-1})
 - Cross section(7%), Mass (2 GeV)
 - spin correlations, charge, top-gauge boson couplings
- Precision measurements of Top quark and W Boson mass \Rightarrow constrain the Higgs Boson
- Direct Searches for the Higgs Boson
 - Run 2A: $M_H > 115 \text{ GeV}$
 - Run 2B: $M_H > 180 \text{ GeV}$ or see signal

Conclusion

- First physics results at 1.96 TeV
 - W and Z production cross sections
 - first generation LQ limit, limit on Large Extra Dimensions, many more analyses in the works
- Enormous progress made over the last year
 - detector performance optimization
 - developing analysis tools
- Improvements in store:
 - optimization of event reconstruction and selection procedures
 - triggers and DAQ performances
 - calibration and alignment of the detectors
- Looking forward to large integrated luminosity!